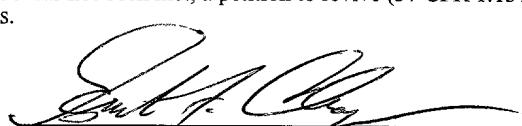


U.S. DEPARTMENT OF COMMERCE PATENT AND TRADEMARK OFFICE FORM PTO-1390 REV. 2/01		ATTORNEY'S DOCKET NUMBER 03940.0056
<b>TRANSMITTAL LETTER TO THE UNITED STATES DESIGNATED/ELECTED OFFICE (DO/EO/US) CONCERNING A FILING UNDER 35 U.S.C. 371</b>		U.S. APPLICATION NO. (If known, see 37 CFR 1.5) <b>09/889177</b>
INTERNATIONAL APPLICATION NO.  PCT/SE00/00089	INTERNATIONAL FILING DATE  January 18, 2000	PRIORITY DATE CLAIMED  January 18, 1999
TITLE OF INVENTION  AN ARTICLE IDENTIFICATION TAG, AND A METHOD FOR THE DETECTION THEREOF		
APPLICANT(S) FOR DO/EO/US  Carl TYRÉN		
<p>Applicant(s) herewith submits to the United States Designated/Elected Office (DO/EO/US) the following items and other information:</p> <p>1. <input checked="" type="checkbox"/> This is a <b>FIRST</b> submission of items concerning a filing under 35 U.S.C. 371.      2. <input type="checkbox"/> This is a <b>SECOND</b> or <b>SUBSEQUENT</b> submission of items concerning a filing under 35 U.S.C. 371.      3. <input type="checkbox"/> This is an express request to begin national examination procedures (35 U.S.C. 371(f)). The submission must include items (5), (6), (9) and (21) indicated below.      4. <input checked="" type="checkbox"/> The US has been elected by the expiration of 19 months from the priority date (Article 31).      5. <input checked="" type="checkbox"/> A copy of the International Application as filed (35 U.S.C. 371 (c)(2)).          a. <input checked="" type="checkbox"/> is attached hereto (required only if not communicated by the International Bureau).          b. <input type="checkbox"/> has been communicated by the International Bureau.          c. <input type="checkbox"/> is not required, as the application was filed with the United States Receiving Office (RO/US).      6. <input type="checkbox"/> An English language translation of the International Application as filed (35 U.S.C. 371 (c)(2)).          a. <input type="checkbox"/> is attached hereto.          b. <input type="checkbox"/> has been previously submitted under 35 U.S.C. 154 (d)(4).      7. <input checked="" type="checkbox"/> Amendments to the claims of the International Application under PCT Article 19 (35 U.S.C. 371 (c)(3)).          a. <input type="checkbox"/> are attached hereto (required only if not communicated by the International Bureau).          b. <input type="checkbox"/> have been communicated by the International Bureau.          c. <input type="checkbox"/> have not been made; however, the time limit for making such amendments has NOT expired.          d. <input checked="" type="checkbox"/> have not been made and will not be made.      8. <input type="checkbox"/> An English language translation of the amendments to the claims under PCT Article 19 (35 U.S.C. 371 (c)(3)).      9. <input type="checkbox"/> An oath or declaration of the inventor(s) (35 U.S.C. 371 (c)(4)).      10. <input checked="" type="checkbox"/> Annexes of the International Preliminary Examination Report.</p> <p>Items 11 to 20 below concern document(s) or information included:</p> <p>11. <input checked="" type="checkbox"/> Information Disclosure Statement under 37 CFR 1.97 and 1.98.      12. <input type="checkbox"/> An assignment document for recording. A separate cover sheet in compliance with 37 CFR 3.28 and 3.31 is included.      13. <input type="checkbox"/> A <b>FIRST</b> preliminary amendment.      14. <input type="checkbox"/> A <b>SECOND</b> or <b>SUBSEQUENT</b> preliminary amendment.      15. <input type="checkbox"/> A Substitute specification.      16. <input type="checkbox"/> A change of power of attorney and/or address letter.      17. <input type="checkbox"/> A computer-readable form of the sequence listing in accordance with PCT Rule 13ter.2 and 35 U.S.C. 1.821-1.825.      18. <input type="checkbox"/> A second copy of the published international application under 35 U.S.C. 154 (d)(4).      19. <input type="checkbox"/> A second copy of the English language translation of the international application 35 U.S.C. 154 (d)(4).      20. <input checked="" type="checkbox"/> Other items or information:          a. <input checked="" type="checkbox"/> Copy of cover page of International Publication No. WO00/42450.          b. <input type="checkbox"/> Copy of Notification of Missing Requirements.          c. <input type="checkbox"/></p>		

U.S. APPLICATION NO. (If known, see 37 CFR 1.47)		INTERNATIONAL APPLICATION NO. PCT/SE00/00089	ATTORNEY'S DOCKET NUMBER 03940.0056
21. <input checked="" type="checkbox"/> The following fees are submitted:		CALCULATIONS PTO USE ONLY	
<b>BASIC NATIONAL FEE (37 CFR 1.492 (a) (1) - (5)):</b>			
Neither international preliminary examination fee (37 CFR 1.482) nor international search fee (37 CFR 1.445(a)(2)) paid to USPTO and International Search Report not prepared by the EPO or JPO ..... \$1000.00			
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search Report prepared by the EPO or JPO ..... \$860.00			
International preliminary examination fee (37 CFR 1.482) not paid to USPTO but International Search fee (37 CFR 1.445(a)(2)) paid to USPTO ..... \$710.00			
International preliminary examination fee (37 CFR 1.482) paid to USPTO but all claims did not satisfy provisions of PCT Article 33(1)-(4) ..... \$690.00			
International preliminary examination fee (37 CFR 1.482) paid to USPTO and all claims satisfied provisions of PCT Article 33 (1)-(4) ..... \$100.00			
<b>ENTER APPROPRIATE BASIC FEE AMOUNT =</b>			
\$1000.00			
Surcharge of <b>\$130.00</b> for furnishing the oath or declaration later than months from the earliest claimed priority date (37 CFR 1.492 (e)). <input type="checkbox"/> 20 <input type="checkbox"/> 30			
\$			
CLAIMS	NUMBER FILED	NUMBER EXTRA	RATE
Total Claims	17	- 20 = 0	x \$18.00
Independent Claims	2	-3 = 0	x \$80.00
MULTIPLE DEPENDENT CLAIM(S) (if applicable)			+\$270.00
<b>TOTAL OF THE ABOVE CALCULATIONS =</b>			\$1270.00
<input type="checkbox"/> Applicant claims small entity status. See 37 CFR 1.27. The fees indicated above are reduced by ½.			
<b>SUBTOTAL =</b> \$1270.00			
Processing fee of <b>\$130.00</b> for furnishing the English translation later than months from the earliest priority date (37 CFR 1.492(f)). <input type="checkbox"/> 20 <input type="checkbox"/> 30			
<b>TOTAL NATIONAL FEE =</b> 1270.00			
Fee for recording the enclosed assignment (37 CFR 1.21 (h)). The assignment must be accompanied by an appropriate cover sheet (37 CFR 3.28, 3.31). <b>\$40.00</b> per property. +			
<b>TOTAL FEES ENCLOSED =</b> \$1270.00			
			Amount to be refunded:
			charged: \$
<p>a. <input checked="" type="checkbox"/> A check in the amount of <u>\$ 1270.00</u> to cover the above fees is enclosed.</p> <p>b. <input type="checkbox"/> Please charge my Deposit Account No. _____ in the amount of <u>\$</u> to cover the above fees. A duplicate copy of this sheet is enclosed.</p> <p>c. <input checked="" type="checkbox"/> The Commissioner is hereby authorized to charge any additional fees which may be required, or credit any overpayment to Deposit Account No. <u>06-0916</u>. A duplicate copy of this sheet is enclosed.</p> <p>d. <input type="checkbox"/> Fees are to be charged to a credit card. <b>WARNING:</b> Information on this form may become public. <b>Credit card information should not be included on this form.</b> Provide credit card information and authorization on PTO-2038.</p>			
NOTE: Where an appropriate time limit under 37 CFR 1.494 or 1.495 has not been met, a petition to revive (37 CFR 1.137 (a) or (b)) must be filed and granted to restore the application to pending status.			
SEND ALL CORRESPONDENCE TO:			
Finnegan, Henderson, Farabow, Garrett & Dunner, L.L.P. 1300 I Street, N.W. Washington, D.C. 20005-3315			
 SIGNATURE Ernest F. Chapman, Reg. No. 25,961 NAME/REGISTRATION NO.			
DATED: July 12, 2001			

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TITLE: **AN ARTICLE IDENTIFICATION TAG, AND A  
METHOD FOR THE DETECTION THEREOF**

**Technical Field**

5 The present invention relates to article identification tags and the detection thereof. More particularly, the invention relates to article identification tags having a plurality of electrically conductive members. The invention also relates to a method 10 of detecting such an article identification tag.

**Prior Art**

15 Many applications require a reliable and contactless detection of the presence, identity or position of objects within a detection zone. Common examples are for instance price labeling of commercial articles, identification of components in production lines, identification of material type at recycling plants or electronic article surveillance in e.g. shops.

20 For some applications it is sufficient to detect the presence of the object or article. One example is a simple electronic article surveillance system, which is arranged to provide an alarm signal, once a protected article is carried into a detection zone. Such a simple application 25 uses a tag having one single sensor element in the form of a thin metal strip or wire with magnetic properties. The sensor element may be detected magnetically by means of arc-shaped magnetic generators/detectors, which expose the sensor element to an alternating magnetic field, that 30 affects a physical property of the sensor element. Use is often made of the fact that the alternating magnetic field causes a periodical switch of the magnetic momentum of dipole of the sensor element, which is also known as Barkhausen jumps. Tags of this kind are for instance 35 disclosed in US-A-5 496 611, EP-A-0 710 923 and EP-A-0 716 393.

DRAFTING BY DRAFTING

A different single-element tag technology is described in WO97/29463 and WO97/29464, wherein each tag comprises a wire-shaped element of amorphous or nano-crystalline metal alloy. An important feature of the 5 amorphous or nano-crystalline metal alloy is that the permeability thereof may be controlled by an alternating magnetic modulating field. Through a physical effect known as Giant Magnetoimpedance, the amplitude of an electromagnetic reply signal from the tag is modulated by the 10 magnetic modulating field, when the tag is excited by an electromagnetic interrogation signal. The modulation in amplitude of the reply signal is detected and used for determining the presence of the tag in the detection zone. A similar application is shown in WO98/36393, where very 15 thin amorphous or nano-crystalline wires are used as sensor elements. These wires (also known as microwires) have a diameter of less than 30  $\mu\text{m}$ , preferably 5-15  $\mu\text{m}$ .

None of the electronic article surveillance applications described above provides a remotely detectable identity for each tag. However, for advanced applications it is necessary to provide such identity information, representing e.g. an article number, serial number, material code, etc., for the respective object, to which each tag is attached. In a different technical field, such identity 20 information is provided by barcodes (such as EAN), i.e. a printed pattern of black and white lines, which is scanned by an optical reader. Optical barcode tags have an advantage in that they offer a wide codespan - an EAN barcode may for instance represent a 12-digit article 25 number, thereby theoretically providing a codespan of  $10^{12}$  different barcode values. Optical article identification systems have a distinct drawback, however, in that the operating distance thereof is quite restricted; the barcode tag will have to pass in close proximity with the 30 optical reader for allowing a successful reading of the 35

barcode. Furthermore, since the barcode is read by optical means, the tag must be attached to a visible surface portion of the article in question.

A non-optical system with longer operating range is disclosed in WO88/01427, wherein the tag or marker is provided with a number of sensor elements in the form of magnetostrictive strips or ribbons made of an amorphous ferromagnetic material and arranged in predetermined angular relationships or at predetermined distances from each other. The identity of such a tag is represented by the predetermined relationships as well as the respective type of individual sensor elements. The sensor elements are excitable to mechanical resonance by magnetic energy. The magnetic signals generated by the resonating sensor elements may be detected magnetically or inductively. Compared to optical barcode systems, the tag of WO88/01427 provides a significantly more limited codespan.

A similar system is described in WO93/14478, wherein the tag or markers are provided with a number of electrical resonant circuits, each of which is inductively coupled to a respective magnetic sensor element. Each electrical resonant circuit is excited to oscillate electrically, and the resonant frequency thereof is controllable, through the permeability of the magnetic element, by an external magnetic field, wherein a simultaneous detection of several identical tags is made possible.

In summary, prior art tags for remote non-optical detection of objects are either of a single-element type, allowing only the presence of each tag to be detected, or of a multi-element type, allowing also an identity of each tag to be detected. Single-element tags are easier to design and produce and therefore have a lower unit cost. On the other hand, multi-element tags require a supporting carrier (particularly for mechanically resonating sensor

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elements) and/or capacitive and inductive components (for the electric resonant circuit versions). Naturally, this implies a higher cost per unit. Furthermore, the codespan (number of different code values) of the multi-element tags described above is clearly inferior in comparison with optical barcode tags. Additionally, since the multi-element tags mainly operate by magnetic or inductive link, the operating distance of the detection system is quite narrow (although better than for optical barcode systems).

10 US-A-4 350 883 discloses a method of detecting an article identification tag having a plurality of metallic wires. Each metallic wire is selected from a range of specimens of different electric conductivity or, possibly, different magnetic permeability. The metallic wires are used as marking or coding elements to represent the code or identity of the tag. When detecting the tag in US-A-4 350 883, the wires are exposed to a high-frequency electromagnetic field, the frequency of which is varied either between two distinct frequencies or continuously. A variation in a corresponding response signal is picked up.

#### Summary of the Invention

Therefore, an object of the present invention is to provide an article identification tag at a considerably lower cost than previously known tags. More specifically, the invention aims at providing a tag, which combines the good characteristics of optical barcode tags (large code span) and non-optical multi-element tags (long operating distance) at a very low price per tag.

30 It is a further object of the invention to provide a method of detecting an article identification tag according to the above.

The objects of the invention have been achieved through the inventive understanding that basically any electrically conductive material can be used as material for the sensor elements of the tag, thanks to the novel detection method according to one aspect of the invention. For instance, a piece of copper or aluminium wire will make an excellent tag. Alternatively, magnetic materials such as simple iron or steel wires may be used.

45 The objects of the invention are achieved by the appended independent patent claims. Other objects, features and advantages of the present invention will also appear from the following detailed disclosure, from the drawings as well as from the subclaims.

**Brief Description of the Drawings**

The present invention will now be described in more detail, reference being made to the accompanying drawings, in which:

5 FIG 1 illustrates an article identification system, in which the method and the tag according to the present invention may be applied,

10 FIGS 2 and 3 are diagrams illustrating the physical basis behind the method according to the present invention, and

15 FIGs 4-7 are schematic illustrations of different exemplifying embodiments of a tag according to the invention.

**Detailed Disclosure of the Invention**

FIG 1 illustrates an article identification system for detecting a tag 30 attached to an object 20, and for determining an identity thereof. A system similar to the one illustrated in FIG 1 is thoroughly disclosed in WO 97/29463, WO 97/29464 and WO 98/36393, all of which are fully incorporated herein by reference. A transmitter antenna 11 and a receiver antenna 12 are arranged in a detection zone 10. The transmitter antenna 11 is operatively connected to an output stage 13, which in turn is connected to a controller 14. The output stage comprises various commercially available driving and amplifying circuits and means for generating an alternating electric current of high frequency  $f_{HF}$ , said current flowing back and forth through the transmitter antenna 11 when supplied thereto, wherein a high-frequency electromagnetic field is generated around the transmitter antenna. This electromagnetic field is used, as will be described in more detail below, for exciting the tag 30 within the detection zone 10, so that the tag will transmit, at the reception of a first electromagnetic

signal 50 from the transmitter antenna 11, a second electromagnetic signal 60, which is received by the receiver antenna 12 and transformed into a corresponding electric signal 70.

5 The receiver antenna 12 is operatively connected to an input stage 15, which comprises conventional means with amplifying and signal processing functions, such as band-pass filtering and amplifying circuits. The input stage 15 also comprises means for demodulating the received signal  
10 70 and supplying it, as a reply signal 80, to the controller 14.

15 The transmitter antenna 11 as well as the receiver antenna 12 thus have the purpose of converting, in a known way, between an electrical signal of high frequency and an electromagnetic signal. Preferably, the antennas are helically formed antennas with rotating polarization (for optimal coverage in all directions), or alternatively conventional end-fed or center-fed halfwave whip antennas, but other known antenna types are equally possible.

20 The detection zone 10 may optionally be provided with means 16, such as a coil, for generating a magnetic modulating field  $H_{mod}$ . The means 16 is connected to the controller 14 via a driving stage 17. The driving stage 17 comprises means for generating a modulating current, which  
25 is supplied to the means 16, wherein the magnetic modulating field  $H_{mod}$  is generated in essential portions of the detection zone 10. The magnetic modulating field  $H_{mod}$  may have a frequency of about 500-800 Hz, and the electromagnetic excitation and reply signals may have a frequency  
30 within the GHz band, such as 1.3 GHz or 2.45 GHz. Frequencies outside these ranges are however also possible.

35 As described above, the object 20, which has been schematically illustrated in FIG 1 in the form of a box-shaped package, is provided with the tag 30 according to the invention, comprising a number of electrically

conductive members 31-3n (FIG 4), which provide an identity of the tag 30, or of the object 20 to which the tag is attached, as will be described in more detail below.

5 The members 31-3n are electromagnetically detectable. Optionally, if a means 16 is used as in FIG 1 for generating a magnetic modulating field  $H_{mod}$ , the members 31-3n may comprise a magnetic material, the permeability of which is controllable by a magnetic field and the high-  
10 frequency impedance of which depends on said permeability, according to an effect commonly known as Gigant Magneto- Impedance. This effect causes a modulation in amplitude of the second electromagnetic signal 60 transmitted from the tag 30 and received by the receiver antenna 12 as the  
15 signal 70. The amplitude is modulated by the magnetic modulating field  $H_{mod}$ .

The detection method according to the present invention will now be described with reference to FIGs 2 and 3. The method according to the invention is based on  
20 novel use of a skin-depth phenomenon known per se, which occurs for high-frequency electrical signals in electrical conductors. Skin-depth is a common name for the fact that the conduction of electrical current will only take place in an outer layer or skin layer of the conductor at high  
25 frequencies. The penetration depth is related to the signal frequency as well as the electrical resistivity and magnetic permeability of the conductor.

An electrically conductive member 1, such as an arbitrary one of the members 31-3n (FIG 4) of the sensor 30 indicated in FIG 1, is illustrated in cross-section in FIG 2. The electrically conductive member 1 has a radius  $R$  and a skin-depth  $d$ , which according to the above varies with the signal frequency. Therefore, the effective impedance  $R_{eff}$  (FIG 3) of the electrically conductive member 1 is  
35 related to the skin-layer cross-sectional area  $S$ , i.e. the

area where the electrical currents are conducted at the signal frequency in question. More specifically, the effective conductor impedance  $R_{eff} = S \cdot \rho_{conductor}$ , where  $\rho_{conductor}$  is the electrical resistivity of the member 1.

5 Since the skin-layer cross-sectional area S will depend on the skin-depth d, which in turn depends on the signal frequency, the effective conductor impedance  $R_{eff}$  will vary with the signal frequency, provided that the signal frequency is not reduced to an extent, where the skin-depth 10 d reaches and equals the radius R of the electrically conductive member 1.

FIG 3 illustrates the effective impedance  $R_{eff}$  of the electrically conductive member 1 when exposed to an electromagnetic high-frequency (HF) signal, such as the 15 excitation signal 50 submitted by the transmitter 11 of FIG 1. As long as the HF frequency is high enough (frequency  $f_1$ ), the effective impedance  $R_{eff}$  of the electrically conductive member 1 will have a continuous waveform, as illustrated in the left-most portion of the graph shown in FIG 3. On the other hand, when the HF frequency is reduced 20 to a frequency  $f_2$ , where the skin-depth d reaches and equals the radius R of the electrically conductive member 1, the effective impedance  $R_{eff}$  of the member 1 will stop to decrease, even if the HF frequency is reduced further. 25 Therefore, a discontinuity point occurs in the relation between effective conductor impedance and HF frequency shown in FIG 3, where  $d = R$ . According to the invention, this discontinuity point is used for detecting an article identification tag 30 and/or determining an identity 30 thereof.

Consequently, according to a method of detecting an article identification tag 30 having at least one electrically conductive member 1, the following steps are performed. An alternating electric current is caused to 35 flow through the member 1, for instance by exciting the

member 1 by means of a high-frequency electromagnetic field, such as the excitation signal 50 of the system shown in FIG 1. The frequency of the alternating electric current is varied, and a corresponding variation in impedance is 5 monitored for the member 1. This correspondingly varying impedance may for instance be monitored via the reply signal 60 received by the receiver antenna 12 in FIG 1. Then, a discontinuity is detected in the varying impedance, and the frequency at which this discontinuity appears is 10 detected. By selecting an electrically conductive member 1, which has a predetermined diameter, a predetermined electrical resistivity or a predetermined magnetic permeability, this frequency (at which the discontinuity appears) will also be predetermined and may be used for 15 providing the member 1 with an identity, since the skin-depth thereof depends on all these parameters.

FIG 4 illustrates a first embodiment of a tag 30 according to the invention. The tag 30 comprises n electrically conductive members 31, 32, 33...3n, having 20 respective predetermined diameters  $\phi_1-\phi_n$ , respective predetermined electrical resistivities  $\rho_1-\rho_n$  or respective predetermined magnetic permeabilities  $\mu_{r1}-\mu_{rn}$ . Combinations of these parameters are also possible. Hence, each 25 electrically conductive member 31-3n of the tag 30 will have one of the above predetermined properties, and consequently the frequency at which the discontinuity appears in the reply signal from the tag 30 will also be well-defined. The tag 30 of FIG 4 is particularly well adapted for use in an electromagnetic article surveillance 30 system, such as the one illustrated in FIG 1.

FIG 5 illustrates a second embodiment of a tag 34, having a plurality of interconnected sections with different respective diameters  $\phi_1$ ,  $\phi_2$ ,  $\phi_3$  and  $\phi_4$ .

FIGs 6 and 7 illustrate further embodiments of a tag 35, 36, respectively, according to the invention. In FIG 6,

the tag 35 comprises five interconnected members having different respective predetermined diameters, electrical resistivities and/or magnetic permeabilities. In FIG 6, the tag 36 comprises nine different interconnected electrically 5 conductive members.

A simpler tag, comprising only one electrically conductive member, may also be used according to the invention. For instance, considering a standard anti-theft inductive-coupling pedestal system used in many shops, a 10 tag may be used consisting of e.g. a copper wire wound in a single-turn loop. By applying an FM-modulating inductive excitation signal having a frequency deviation, which sweeps past the tag discontinuity frequency, an AM-modulated tag signal will be received in the pick-up coils 15 of the pedestals. This AM modulation results from the change in impedance of the copper wire loop, as its skin-depth changes with the excitation frequency. Starting at the maximum frequency, the AM signal will increase in amplitude, as the frequency decreases and the skin-depth increases. However, at the frequency where the skin-depth 20 reaches the radius of the copper wire, the loop impedance will abruptly cease to decrease, and a plateau (or flat region) will appear in the received AM signal. Such a signal clipping will indicate the presence of the tag in 25 the anti-theft detection zone and will be a criterion for triggering an alarm. In other words, the clipping region represents the frequency interval, during which the skin-depth exceeds the radius of the conductor.

Different electronic or digital signal processing 30 techniques may be utilized to precisely determine the frequency of the amplitude modulation (voltage drop) discontinuity related to the frequency modulation of the applied alternating signal. One such technique involves an amplitude demodulation of the alternating voltage drop

signal, followed by subtraction of the FM reference signal in order to detect the discontinuity point.

One particular advantage of the invention is that the conductor radius detection criterion represents a discontinuity in the measuring signal, which may be easily distinguished from continuously varying features in the measuring signal, resulting from e.g. frequency-related changes in inductance, reflections, capacitive couplings, etc.

As an alternative to solid electrically conductive members, also tubular conductors may be used for article identification tags. Here, the thickness of the tube wall will define the discontinuity point. One such implementation, particularly suitable for e.g. the fashion industry, would be a metallized synthetic fiber. One advantage of a tubular conductor over a solid conductor is that the total volume of conductive material will be larger for the same skin-depth saturation point, thereby providing larger tag signal levels.

The multi-member tag embodiments shown in FIGS 4-7 will assist in reducing the risk of false alarms, since the multi-member tag will be provided with an identity thanks to the predetermined respective diameters, resistivities and/or permeabilities.

Yet another possibility to reduce the risk of false alarms and to add a further information coding parameter is to use non-circular cross-sections e.g. rectangular cross-sections. In such a case, the minimum dimension may be measured by the discontinuity point. For e.g. a rectangular cross-section, the thickness would be measured through the discontinuity point. The width may then be measured by using a secondary effect of the skin-depth, namely that for a certain change in skin-depth (related to a certain change in frequency), the corresponding change in effective impedance will depend on the width.

The electrically member(s) described for the different embodiments above may be given many different shapes, e.g. in the form of wires, strips or ribbons, and may comprise various different materials, such as non-  
5 magnetic metals (e.g. copper or aluminium), magnetic metals (e.g. iron), metal alloys (e.g. steel), or alternatively amorphous metal alloys.

The invention has been described above with reference to a few embodiments. However, other embodiments than the  
10 ones disclosed are equally possible within the scope of the invention, as is readily realized by a man skilled in the art.

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## CLAIMS

1. A method of detecting an article identification tag (30) having at least one electrically conductive member (31-3n), wherein, for each of said at least one member (31-3n), an alternating electric current is caused to flow through said member, a frequency of the alternating electric current is varied, and a corresponding variation in impedance of said member is monitored, characterized by the steps of

detecting a discontinuity in said variation in impedance; and

detecting the frequency of the alternating electric current, at which frequency said discontinuity appears.

15 2. A method according to claim 1, wherein each of said at least one electrically conductive member (31-3n) has one of a predetermined diameter, a predetermined electrical resistivity or a predetermined magnetic permeability, and wherein said predetermined diameter, resistivity or permeability is mapped to information about an identity of the tag (30).

25 3. A method as in claim 1 or 2, wherein the alternating electric current is induced in said at least one electrically conductive member (31-3n) by exposing the tag (30) to an alternating electromagnetic field.

30 4. A method as in any preceding claim, wherein the alternating electric current is induced in said at least one electrically conductive member (31-3n) by exposing the tag (30) to a magnetic field.

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5. A method as in any preceding claim, wherein said at least one electrically conductive member (31-3n) is an elongated metallic member having the form of a wire, strip or ribbon.

5

6. A method as in claim 5, wherein the elongated magnetic member (31-3n) comprises a non-magnetic metal, preferably copper or aluminium.

10

7. A method as in claim 5, wherein the elongated metallic member comprises a magnetic material, preferably iron, steel or an amorphous metal alloy.

15

8. An article identification tag (30) comprising a plurality of electrically conductive members (31-3n), characterized in that each of the electrically conductive members (31-3n) has a unique predetermined diameter.

20

9. A tag as in claim 8, wherein the electrically conductive members (31-3n) are formed as metallic wires, strips or ribbons.

25

10. A tag as in claim 9, wherein the metallic wires, strips or ribbons (31-3n) comprise a non-magnetic metal, preferably copper or aluminium.

30

11. A tag as in claim 9, wherein the metallic wires, strips or ribbons comprise a magnetic material, preferably iron, steel or an amorphous metal alloy.

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12. A tag as in any of claims 8 to 11, wherein at least some of the electrically conductive members (35, 36) have galvanic contact with each other.

5 13. A tag as in any of claims 8 to 12, wherein the electrically conductive members (34) are formed by an elongated element having sections of different diameters.

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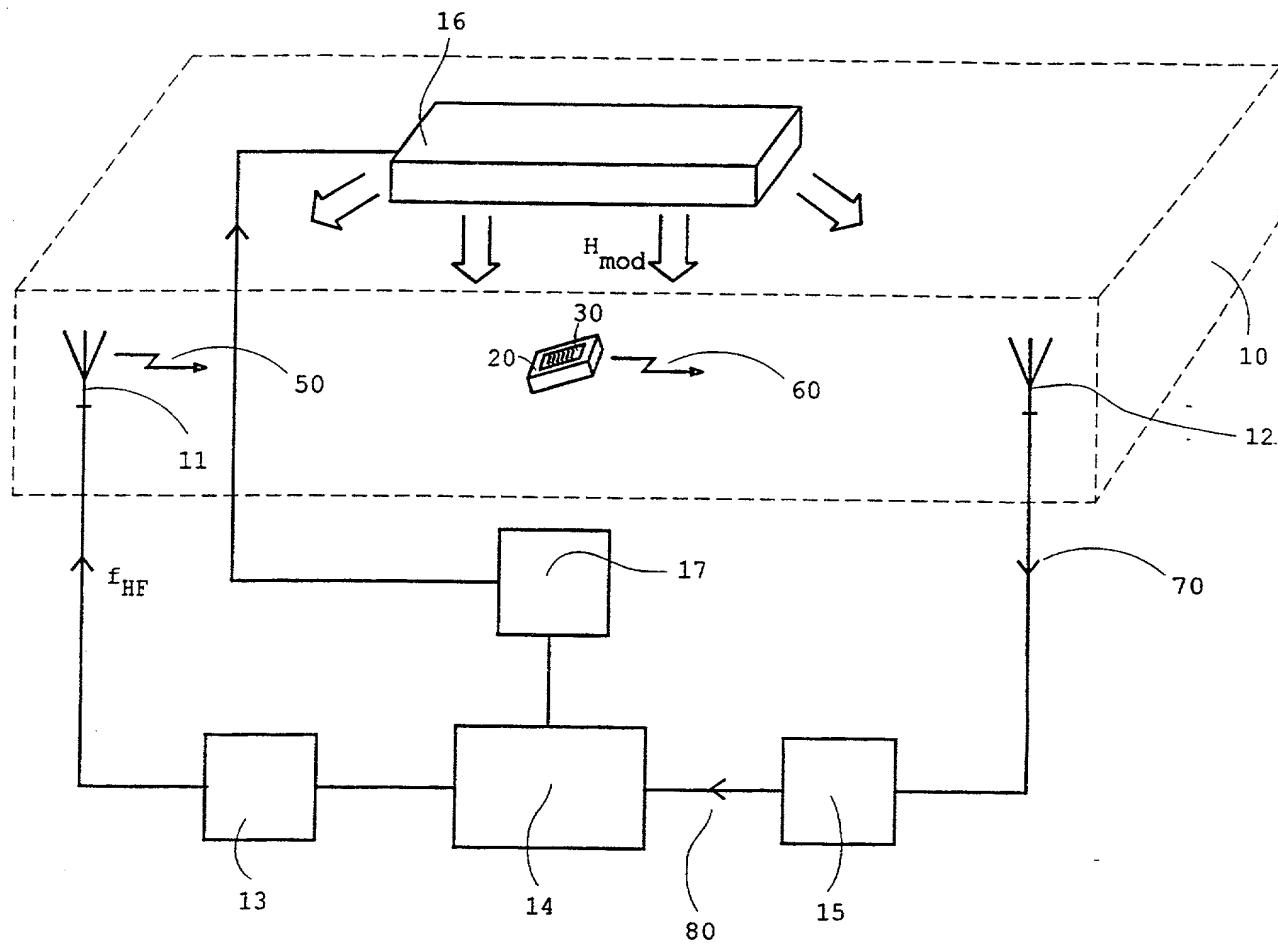


FIG 1

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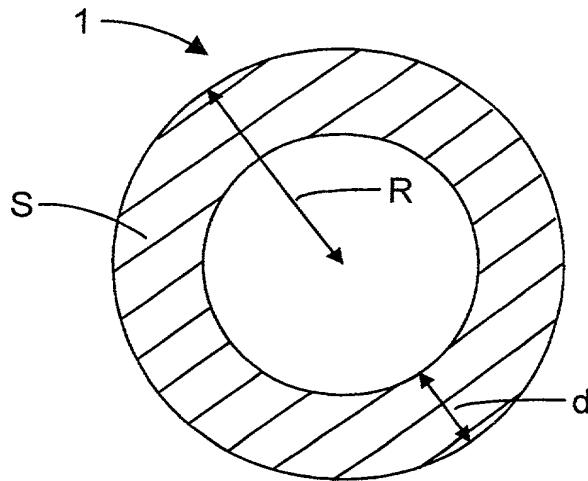


FIG 2

Effective conductor  
impedance

$$R_{\text{eff}} = S \cdot \rho_{\text{conductor}}$$

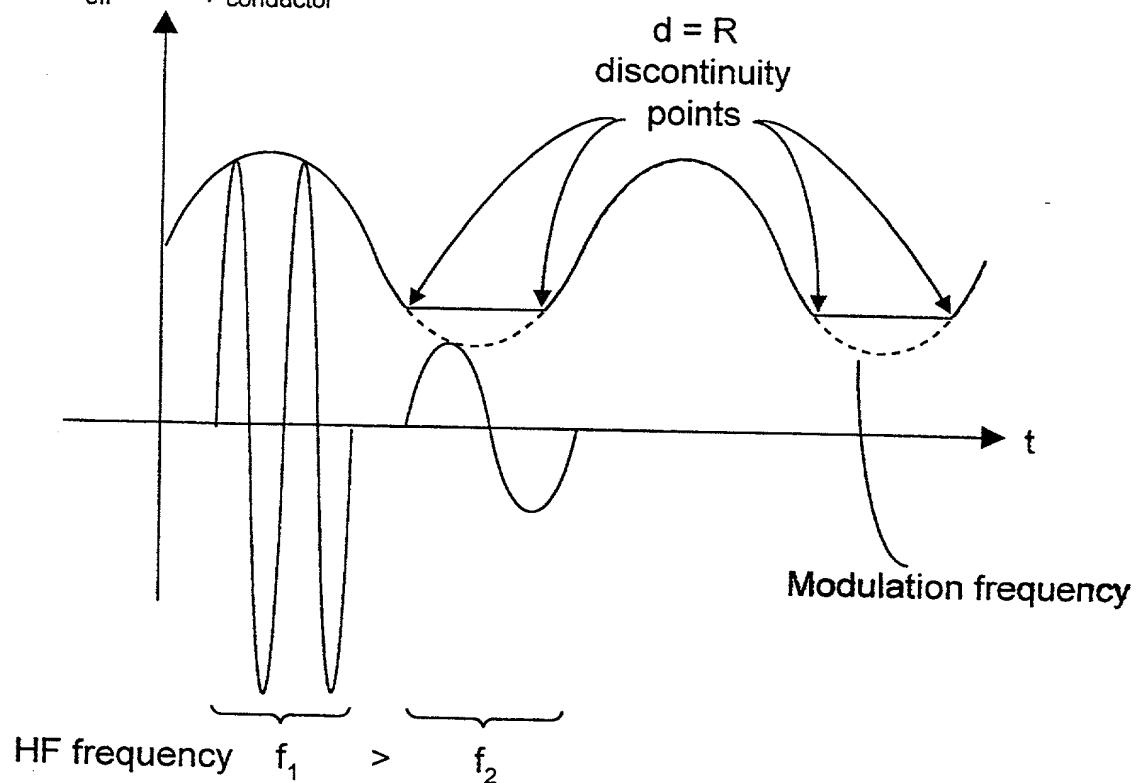


FIG 3

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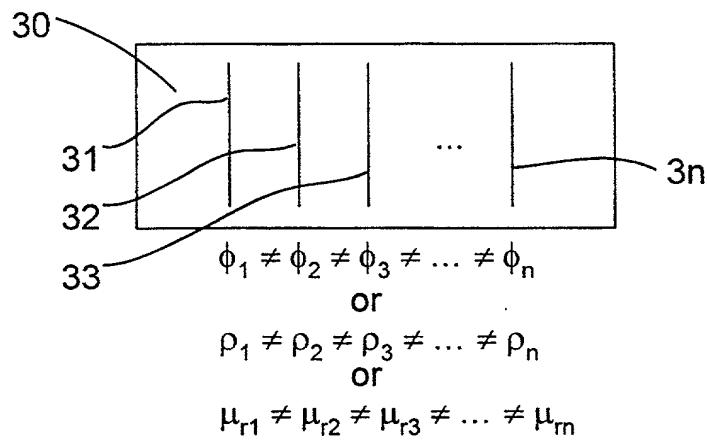


FIG 4

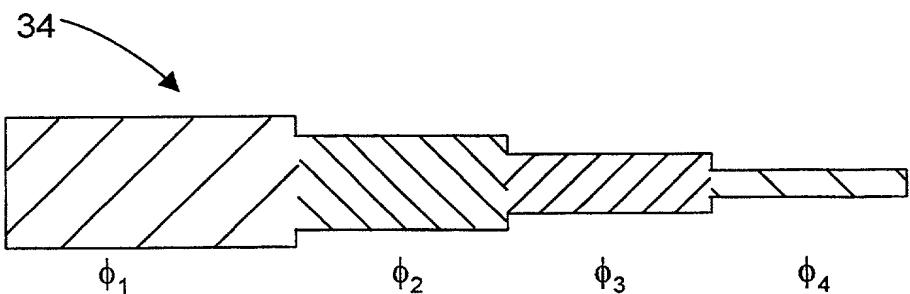


FIG 5

4/4

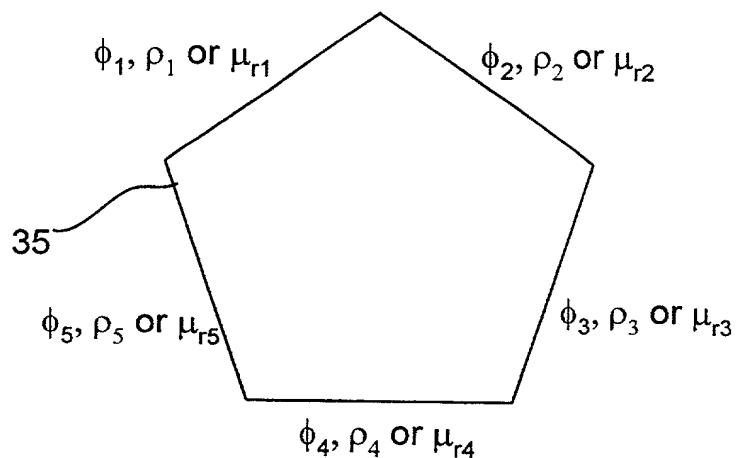


FIG 6

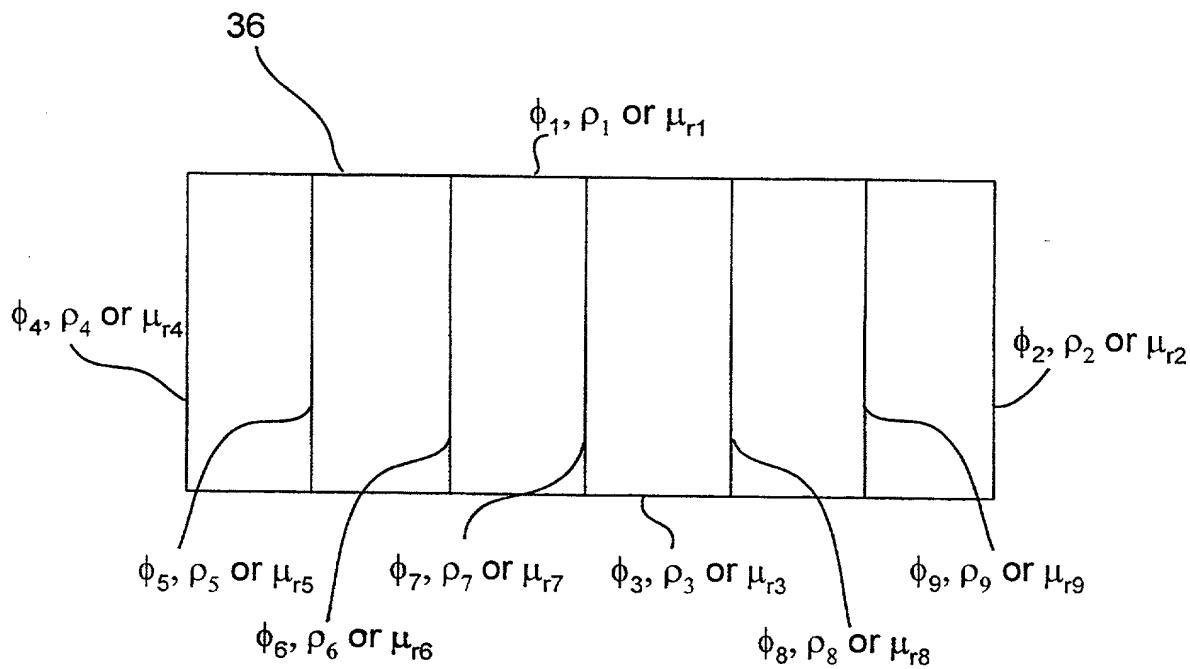


FIG 7

## DECLARATION AND POWER OF ATTORNEY

As a below named inventor, I hereby declare that: My residence, post office address and citizenship are as stated below next to my name; I believe I am the original, first and sole inventor (if only one name is listed below) or an original, first and joint inventor (if plural names are listed below) of the subject matter which is claimed and for which a patent is sought on the invention entitled:

## AN ARTICLE IDENTIFICATION TAG, AND A METHOD FOR THE DETECTION THEREOF

the specification of which:

is attached hereto; or

was filed as United States Application Serial No. \_\_\_\_\_  
on July 12, 2001, and was amended on \_\_\_\_\_  
(if applicable); or

was filed as PCT International Application Number PCT/SE00/00089  
on January 18, 2000 and was amended on February 13, 2000  
(if applicable).

I hereby state that I have reviewed and understand the contents of the above-identified specification, including the claims, as amended by any amendment referred to above. I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56.

I hereby claim foreign priority benefits under 35 U.S.C. § 119(a)-(d) or § 365(b) of any foreign application(s) for patent or inventor's certificate or § 365(a) of any PCT international application(s), designating at least one country other than the United States, listed below and have also identified below any foreign application(s) for patent or inventor's certificate, or any PCT international application(s) having a filing date before that of the application(s) of which priority is claimed:

Country	Application Number	Date of Filing	Priority Claimed Under 35 U.S.C. 119
Sweden	9900119-0	January 18, 1999	<input checked="" type="checkbox"/> YES <input type="checkbox"/> NO
			<input type="checkbox"/> YES <input type="checkbox"/> NO

I hereby claim the benefit under 35 U.S.C. § 119(e) of any United States provisional application(s) listed below:

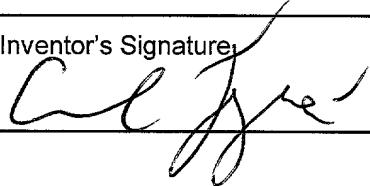
Application Number	Date of Filing

I hereby claim the benefit under 35 U.S.C. § 120 of any United States application(s) or § 365(c) of any PCT international application(s) designating the United States, listed below and, insofar as the subject matter of each of the claims of this application is not disclosed in the prior United States or PCT international application(s) in the manner provided by the first paragraph of 35 U.S.C. § 112, I acknowledge the duty to disclose information which is material to patentability as defined in 37 CFR § 1.56 which became available between the filing date of the prior application(s) and the national or PCT international filing date of this application:

Application Number	Date of Filing	Status (Patented, Pending, Abandoned)

I hereby appoint the following attorney and/or agent(s) to prosecute this application and transact all business in the Patent and Trademark Office connected therewith. **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, L.L.P., Reg. No. 22,540**, Douglas B. Henderson, Reg. No. 20,291; Ford F. Farabow, Jr., Reg. No. 20,630; Arthur S. Garrett, Reg. No. 20,338; Donald R. Dunner, Reg. No. 19,073; Brian G. Brunsvold, Reg. No. 22,593; Tipton D. Jennings IV, Reg. No. 20,645; Jerry D. Voight, Reg. No. 23,020; Laurence R. Hefter, Reg. No. 20,827; Kenneth E. Payne, Reg. No. 23,098; Herbert H. Mintz, Reg. No. 26,691; C. Larry O'Rourke, Reg. No. 26,014; Albert J. Santorelli, Reg. No. 22,610; Michael C. Elmer, Reg. No. 25,857; Richard H. Smith, Reg. No. 20,609; Stephen L. Peterson, Reg. No. 26,325; John M. Romary, Reg. No. 26,331; Bruce C. Zotter, Reg. No. 27,680; Dennis P. O'Reilley, Reg. No. 27,932; Allen M. Sokal, Reg. No. 26,695; Robert D. Bajefsky, Reg. No. 25,387; Richard L. Stroup, Reg. No. 28,478; David W. Hill, Reg. No. 28,220; Thomas L. Irving, Reg. No. 28,619; Charles E. Lipsey, Reg. No. 28,165; Thomas W. Winland, Reg. No. 27,605; Basil J. Lewis, Reg. No. 28,818; Martin I. Fuchs, Reg. No. 28,508; E. Robert Yoches, Reg. No. 30,120; Barry W. Graham, Reg. No. 29,924; Susan Haberman Griffen, Reg. No. 30,907; Richard B. Racine, Reg. No. 30,415; Thomas H. Jenkins, Reg. No. 30,857; Robert E. Converse, Jr., Reg. No. 27,432; Clair X. Mullen, Jr., Reg. No. 20,348; Christopher P. Foley, Reg. No. 31,354; John C. Paul, Reg. No. 30,413; David M. Kelly, Reg. No. 30,953; Kenneth J. Meyers, Reg. No. 25,146; Carol P. Einaudi, Reg. No. 32,220; Walter Y. Boyd, Jr., Reg. No. 31,738; Steven M. Anzalone, Reg. No. 32,095; Jean B. Fordis, Reg. No. 32,984; Barbara C. McCurdy, Reg. No. 32,120; James K. Hammond, Reg. No. 31,964; Richard V. Burgujian, Reg. No. 31,744; J. Michael Jakes, Reg. No. 32,824; Dirk D. Thomas, Reg. No. 32,600; Thomas W. Banks, Reg. No. 32,719; Christopher P. Isaac, Reg. No. 32,616; Bryan C. Diner, Reg. No. 32,409; M. Paul Barker, Reg. No. 32,013; Andrew Chanho Sonu, Reg. No. 33,457; David S. Forman, Reg. No. 33,694; Vincent P. Kovalick, Reg. No. 32,867; James W. Edmondson, Reg. No. 33,871; Michael R. McGurk, Reg. No. 32,045; Joann M. Neth, Reg. No. 36,363; Gerson S. Panitch, Reg. No. 33,751; Cheri M. Taylor, Reg. No. 33,216; Charles E. Van Horn, Reg. No. 40,266; and Linda A. Wadler, Reg. No. 33,218; Jeffrey A. Berkowitz, Reg. No. 36,743; Michael R. Kelly, Reg. No. 33,921; James B. Monroe, Reg. No. 33,971; Doris Johnson Hines, Reg. No. 34,629; Allen R. Jensen, Reg. No. 28,224; Lori Ann Johnson, Reg. No. 34,498; and David A. Manspeizer, Reg. No. 37,540 and Please address all correspondence to **FINNEGAN, HENDERSON, FARABOW, GARRETT & DUNNER, L.L.P.**, 1300 I Street, N.W., Washington, D.C. 20005, Telephone No. (202) 408-4000.

I hereby declare that all statements made herein of my own knowledge are true and that all statements made on information and belief are believed to be true; and further that these statements were made with the knowledge that willful false statements and the like so made are punishable by fine or imprisonment, or both, under section 1001 of Title 18 of the United States Code, and that such willful false statements may jeopardize the validity of the application or any patent issuing thereon.

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